

Role of Encoders and PLC in Electrical Control Drives of CNC Machines and Automation

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Abstract

Today is the age of automation with the applications of Electrical Power and Drives, invariably, in all modern industries, CNC machines, transportation system, Metro Trains, Automobile Vehicles and domestic applications. PLCs and microcontrollers are inbuilt combination of various Digital Integrated Circuits. Most of the automobile vehicles (medium and heavy) are rapidly changing the mechanical drives and engine parts with electrical and electronic control devices. This includes, ignition control, combustion, engine cooling and emergency signals. Electrical drives are playing vital role in speed variation with reduced power consumption for heavy duty motor. In this paper, efforts have been made, to focus on the role and application of Encoder and PLC, in CNC Machines and Automation.

Keywords: PLC, Encoder, Control Devices

INTRODUCTION

An encoder is a device that translates mechanical motion into electronic signal used for position feedback, or we simply say that it is a device used for converting one signal to another for counting or distance measurement. It can be called as Transducer and it may be linked with software programming. It is responsible for speed control, too. We can consider, encoder as a sensing device that gives some feedback.

It convert motion into electrical signal that can be sense by some type of control device in a motion control system, such as counter or PLC.

Then the encoder send the feedback signal that can be used for determine the position, speed, displacement, acceleration or direction. Then controlling devices use this information to send the command for a particular function.

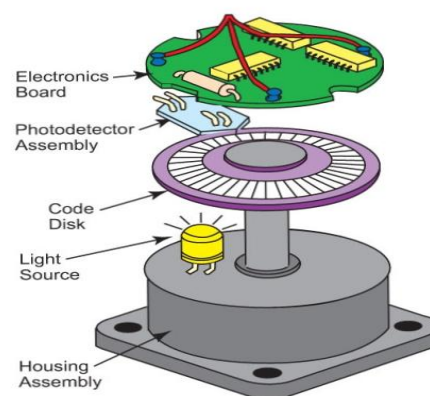


Fig. 1 Schematic Diagram of Rotary Encoder

Although there are many ways to generate output signals, like mechanical or change in output resistance or change in magnetic signal etc., the most widely used in today's industry is optical based. This means the continuity of light is broken and due to this a feedback is generated.

The basic construction of an **incremental rotary encoder** using in optical technology is shown in Fig.1.

In this simple encoding system the light emitted from an LED is used for feedback signal. The light beam from LED is interrupted by opaquelines on code dish before taken up by the Photodetector Assembly, this produces the light signals, then these signal are used for feedback function.

Types of Encoders-

1. Linear encoder
2. Rotary encoder
3. Position encoder
4. Optical encoder

Linear encoder

This type of encoder used for measure the distance between two points .In these cases ,a cable is run between the encoder then transducer gathers data from cable and produces output signal i.e. a linear proportion of the item's movement.

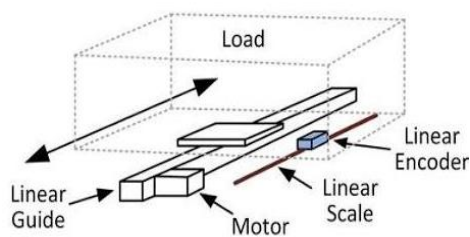


Fig. 2 Schematic Diagram of Linear Encoder

Rotary Encoder

The rotary type coders are counting the RPM of a rotating shaft in CNC machines. It gives output in form of Digital display. This also indicates the angular movement of the rotating shaft.

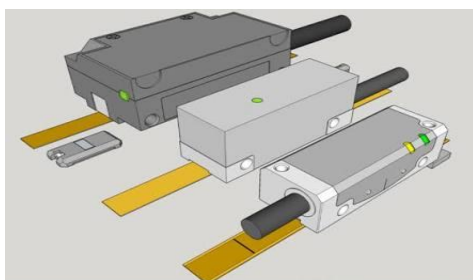


Fig. 3 Schematic Diagram of Rotary Encoder

Position encoder

This Encoder shows the coordinate of the job, on CNC machine table, at starting time (Machine Home position) and at any time, or at the end of machining operation, both, in absolute or incremental mode.

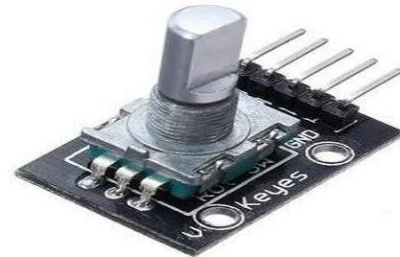


Fig.4 Schematic Diagram of Position Encoder

Optical encoder

Optical encoder interferes with the beam of light and generates signal to produce data. These signals are then analyzed and tell the position and direction of Job or tool.

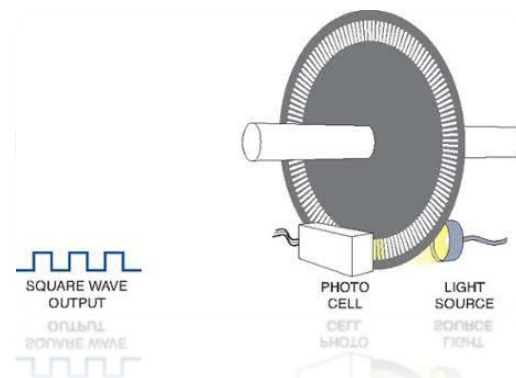


Fig.5 Schematic Diagram of Optical Encoder

Working of rotary encoder-The types of Pulse generated are Square type. The Disc of encoder has eqispaced segments. There are three pins A, B and C as shown in Fig 6. When the disk rotates, A and B pins come in contact with the pin C and the signals in square shape output are generated. It can show the direction of rotation also. There is 900 phase difference at signals A & B.

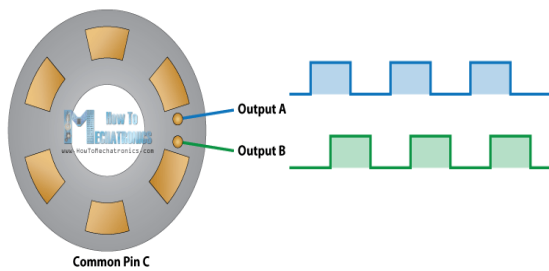


Fig.6 Schematic Diagram of process of Encoder

Working of optical incremental encoder

Optical incremental encoder has most commonly used encoder. A disc moves between a light source and a detector. Their output signal should be sinusoidal or square wave.

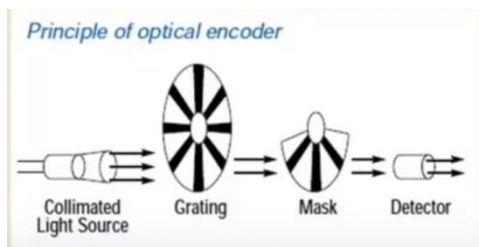


Fig.7 Schematic Diagram of Working of Encoder

Examples

- An audio encoder converts analog audio to digital audio signals.
- A video encoder converts analog video to digital video signals.
- Linear measurement in wire or a cable
- A multiplexer combines multiple inputs into one output.
- 8b/10b encoder used for fast speed in communication system.
- A rotary encoder converts rotary position to an analog or digital electronic signal.

Encoder Life

Encoder life is most often limited due to-

- Optical failure
- Shaft and bearing failure
- Electronic failure

Potential Source of Error

1. Manufacturing and material tolerances

2. Silicon cell characteristics
3. Electrical noise
4. Mechanical vibration
5. Temperature vibration

PLC(Programmable Logic Controller)-

It is a small programmer used in CNC Machines and other Industrial applications. It receives the signals from input devices and gives instructions in return, to the control the machine devices to obtain desired output. It monitors the whole process of machining and shows digitally on output devices..

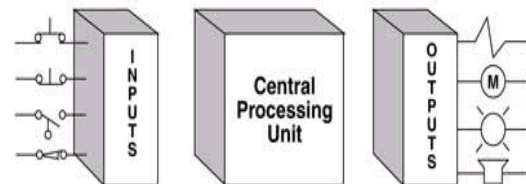


Fig.8 State of Programmable Logic Controller

Invention of PLC and its use in Industries-

The Central Processing Unit, makes an internal program which guides the PLC and performs these tasks:

This executes the operations as described in the Program. This is stored in memory which will not be deleted when power failure is there.

This interfaces with the other operating devices also such as Auxiliary motions, feed, main cutting operations, cooling or ejection etc.

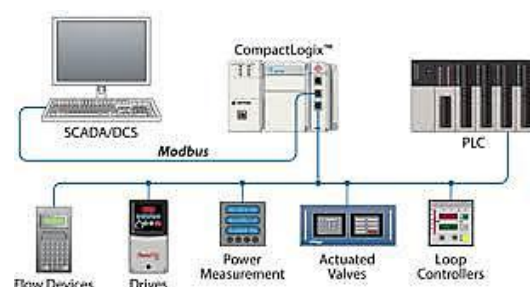


Fig.9 Schematic Diagram of Working of PLC

An example of PLC application, is Pressing Powder Metallurgy Products, on Iso static pressing is given below with sequences of operations-

- It will start Top and bottom punches coming together for pressing.
- Then it will move hopper which contains powder and the powder will be poured into the Die cavities.
- Pressing starts.
- Cooling (Optional)
- Die and punch move away
- The component is hold by Grippers and placed in a tray.

CONCLUSION

Development of the linear and rotary encoders and programmable logic controller (PLC) have made the automation and control of machine tools easier. Encoder are feedback device in a close loop automatic drive system. The CNC

machine are automated with there two Electrical drive components. This is not limiting the electrical drive scope upto induction motor or torque variation only.

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